

Validation of the NSBRI Astronaut Cardiovascular Health and Risk Modification (ASTRO-CHARM) Integrated Cardiovascular Risk Calculator

Completed Technology Project (2015 - 2016)



Project Introduction

In 2012, the National Space Biomedical Research Institute (NSBRI) supported the development of an integrated tool, termed the Astronaut Cardiovascular Health and Risk Modification (ASTRO-CHARM) Integrated Cardiovascular Risk Calculator. The initial version of this tool was delivered to NSBRI in February of 2014 and has already been implemented in spaceflight on an ad hoc basis. This project seeks to update and validate the ASTRO-CHARM calculator.

Specific Aim 1: To refine the ASTROCHARM tool using extended cardiovascular (CV) event data. Version 1 of the ASTROCHARM tool comprised 6782 subjects with a 159 CV events over a mean follow up of 7.5 years. Both the Dallas Heart Study (DHS) and Multiethnic Study of Atherosclerosis (MESA) have now extended their CV event follow up to 10 years. Given the younger age of the cohort and resultant lower event rates, enhancing the endpoint numbers will provide more stability and accuracy for the updated risk score model (ASTRO-CHARM version 2.0).

Specific Aim 2: To validate the ASTROCHARM tool using the Framingham Heart Study coronary artery calcium (CAC) cohort. The ASTRO-CHARM tool demonstrated robust measures of internal validity when assessed in the original combined cohort. These included accurate event rate calibration, as well as improvement in the c-statistic and clinical risk reclassification compared with traditional risk factors alone. However, external validation in another cohort is essential before broader implementation. The Framingham Heart Study (FHS) is the highly regarded original large U.S.-based population-based cohort, where CV risk scores originated. A cohort of the FHS underwent CAC scanning including 2740 subjects <65 years of age, with a mean 8 years of CV event follow up data, and is an ideal study in which to validate the ASTRO-CHARM model.

Specific Aim 3: To develop a mobile device application to facilitate broad implementation of the ASTRO-CHARM tool. The near universal availability of mobile technologies has enabled broader use of more sophisticated risk scores. Prior versions such as the Framingham Risk Score initially used tabular formats and adding of integer points, and were infrequently utilized in clinical practice. The Pooled Cohort Equation as part of the New 2013 ACC/AHA (American College of Cardiology/American Heart Association) Cholesterol Guidelines has witnessed brisk uptake of a more complex algorithm, partly due to a well-received mobile app that has witnessed more than 64,000 downloads in its first two months. Once validated, a similar tool developed for the ASTROCHARM will greatly enhance its clinical impact.

ASTROCHARM Version 2. The investigators have extended endpoint data to include another 145 events (304 total), with a median follow up of 10.9 years. They have used these expanded endpoints to refine the ASTRO-CHARM calculator and assessed measures of internal validity of the new calculator including discrimination and calibration which were all robust. They applied the



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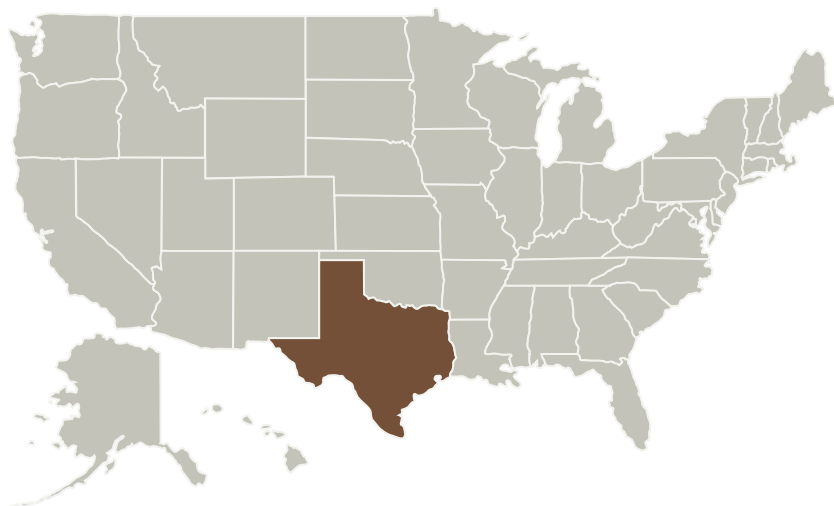


ASTRO-CHARM model to the Framingham Heart Study CAC cohort (n=2057). The ASTRO-CHARM calculator showed good discrimination (c-statistic 0.79) and calibration (Goodness-of-Fit Chi-square: 13.2, p=0.16) in the Framingham study. The authors developed a prototype iPhone app for the ASTRO-CHARM and demonstrated this tool to NASA/NSBRI in late July of 2016. They are preparing the manuscript for scientific publication and the app for broad dissemination for NASA/NSBRI and terrestrial medicine applications.

Anticipated Benefits

Coronary artery calcium scoring is the best validated, and most powerful current novel tool for cardiovascular disease risk assessment. This test is being used broadly in clinical practice; however, there is currently no tool available that integrates traditional risk factor information with coronary artery calcium score to predict atherosclerotic cardiovascular disease (ASCVD) events. Such a tool would be a major advancement for clinical practice, and the ASTROCHARM development plan has including provisions for applications to terrestrial medicine. Specifically, a separate model not including C-reactive protein (CRP) was developed and the mobile app could be rapidly adopted to facilitate office based use.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Operations Mission Directorate (SOMD)

Lead Organization:

National Space Biomedical Research Institute (NSBRI)

Responsible Program:

Human Spaceflight Capabilities

Project Management

Program Director:

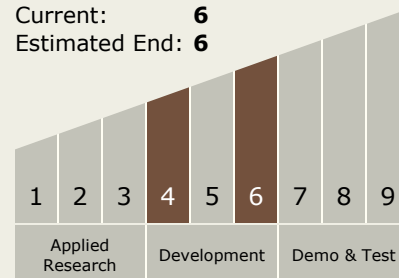
David K Baumann

Principal Investigator:

Amit Khera

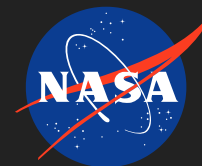
Technology Maturity (TRL)

Start: 4
Current: 6
Estimated End: 6



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Organizations Performing Work	Role	Type	Location
National Space Biomedical Research Institute(NSBRI)	Lead Organization	Industry	Houston, Texas
University of Texas Southwestern Medical Center	Supporting Organization	Academia	Dallas, Texas

Primary U.S. Work Locations

Texas

Project Transitions

 **August 2015:** Project Start

 **July 2016:** Closed out

Closeout Summary: In this year, we have completed the first two specific aims including extending cohort follow up to add additional event data. We have also entered a collaboration with the Framingham Heart Study and completed validation of the ASTROCHARM model in that cohort. The final aim of mobile application development is well advanced with a prototype developed and tested, and demonstrated to NSBRI. We are in the process of finalizing the aesthetics and supplementary text of the app and are writing up the manuscript regarding ASTROCHARM for publication in a scientific journal.

Stories

Articles in Peer-reviewed Journals
(<https://techport.nasa.gov/file/54159>)

Project Website:

<https://taskbook.nasaprs.com>

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - ↳ TX06.3 Human Health and Performance
 - ↳ TX06.3.1 Medical Diagnosis and Prognosis

Target Destinations

The Moon, Mars